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THE ASSOCIATION OF POVERTY AND RESIDENCE IN PREDOMINANTLY BLACK NEIGHBORHOODS WITH THE OCCURRENCE OF PRETERM BIRTHS AMONG BLACK WOMEN: A CASE-CONTROL STUDY OF THREE NORTH CAROLINA METROPOLITAN AREAS

by

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ABSTRACT

Despite efforts to improve the quality and availability of prenatal care in the United States, the risk of preterm births remains significantly higher among black women, compared to women of other race or ethnic groups. Extensive research on black/white differences in poor birth outcomes has failed to produce a clear understanding of the excess risk of prematurity among blacks. Some researchers contend that the injurious effects of racism may contribute to the elevated risk of prematurity among blacks. However, there are few published studies to support this assumption, and none have examined the relationship between prematurity and neighborhood segregation. The present study utilizes census block group data to estimate the effect of poverty and neighborhood segregation status on the risk of both moderate preterm (33-36 weeks gestation) and extreme preterm (18-32 weeks gestation) births among black mothers.

Cases and controls were selected from 1992 births to black mothers residing in Raleigh, Greensboro, and Charlotte, North Carolina. Socioeconomic block group-level data, from the 1990 census, were matched to birth certificates using GIS (Geographical Information System) technologies. Logistic regression was used to assess the joint impact of poverty and segregation on the occurrence of moderate and extreme preterm births, with black normal birthweight term infants serving as controls.

When controlling for smoking, prior fetal loss, and current medical risk factors, the lowest level of income (annual household income under $11,000) was associated with an increased risk for extreme preterm delivery (Odds Ratio=2.1). Conversely, residence in the highest level of block group segregation, (75% or more black households), was found to reduce the risk of extreme prematurity (OR=0.6). For black mothers who delivered moderately preterm babies, no measurable environmental effects were observed. These findings are discussed, as well as limitations of the study and implications for public health practice.

NORTH CAROLINA DEPARTMENT OF HEALTH AND HUMAN SERVICES

INTRODUCTION

Preterm births are known to disproportionately affect blacks in the United States. Compared to white infants, black infants are 1.8 times as likely to be premature (less than 37 weeks gestation) and 2.4 times as likely to be very premature (less than 33 weeks gestation)[1]. Pre-existing medical conditions, such as diabetes, or complications of pregnancy, such as pregnancy-induced hypertension, are known to increase a woman's risk for preterm delivery[2]. However, medical conditions alone do not fully account for the risk of prematurity and do not adequately explain the disparity in black/white preterm birth outcomes.

In a recent study comparing infant mortality among college-educated parents, Schoendorf and colleagues found that black infants were three times as likely as white infants to die of causes attributable to perinatal conditions, including prematurity[3]. The disturbing fact of these results was that an advantaged group of black women, who presumably had access to the same quality of health care as their white counterparts, continued to experience an excess rate of preterm births, particularly preterm, very low birthweight births. Other studies have demonstrated that blacks who were at low risk in terms of socio-demographic factors (i.e., residence in middle income neighborhoods), had higher rates of low birthweight births compared to whites of similar demographic status[4-5]. Such findings have prompted researchers to question the long-held assumption that the excess rate of black infant morbidity is associated mostly with poverty.

Some researchers speculate that racism, in both its structural (institutional) and interpersonal forms, may contribute to the persistently high rates of prematurity found in the black community[6]. Residential segregation persists in U.S. metropolitan areas. Most blacks continue to reside in predominantly black neighborhoods, even in cities with relatively large and affluent black middle classes[7]. These structural aspects of segregation may limit options or access to quality health care[8]. On an interpersonal level, it has been suggested that fre-

quent exposure to negative stereotyping may also cause stress-related health problems, including pregnancy-induced hypertension[9].

Of the few studies that have examined the relationship between birth outcomes and segregation, most have focused on black/white differences in infant mortality. In a study of 38 large metropolitan areas (population greater than 1 million), Polednak found that the gap in the black/white infant mortality rates was higher in metropolitan areas that were more residentially segregated, independent of the economic level of the community[10]. In a similar study of 176 U.S. cities (population 50,000 or more), LaVeist found that black infant mortality was not only higher in highly segregated cities, but also lower in cities with greater black political power[11]. The results of these ecological studies of infant mortality suggest that environmental factors may be associated with birth outcomes. Inclusion of environmental factors, along with individual-level information, may promote a better understanding of the reasons for the increased risk of prematurity among blacks.

Most environmental studies of infant mortality have relied upon census tract data to measure environmental effects – as was the case in the two previous studies. Although intended to be demographically homogeneous, census tracts have been found to be too large to capture single-neighborhood characteristics[12]. The "hill effect" has been observed in tracts where pockets of affluence (on top of the hill) reside alongside less affluent or poor neighborhoods (bottom of the hill)[13]. A better approximation of neighborhood environments are found in sub-tract units, known as block groups. Studies have shown that estimates derived from block group variables are more consistent with those of individual-level variables, than are estimates obtained from census tract variables[12-13].

Comparative studies of black/white birth outcomes have also been criticized for assuming that, when educational or economic factors are entered into the study, blacks and whites share the same opportunities at the same level of socioeconomic

status[14]. Researchers argue that a college degree does not necessarily provide the same standard of living for blacks and whites[15].

For these reasons, it is argued that the study of prematurity among blacks should begin with an understanding of the various risk factors which distinguish black women who deliver prematurely from other black women who live in the same environment and culture, but do not deliver prematurely.

The purpose of this study was to examine the effects that residential segregation and household income status may have on the risk of preterm births among blacks residing in three of the state's largest urban areas. The term "segregation" in this study refers to residence in predominantly black or white neighborhoods. Specifically, this study asks: (1) Is there an independent risk associated with poverty and/or segregation; and (2) Do these environmental risks vary by moderate and extreme prematurity?

METHODS

Sample selection. Study subjects were selected from 1992 births in three North Carolina cities with large minority birth populations (of which more than 95 percent are black). These cities are Raleigh, Greensboro, and Charlotte. County-city codes available on the birth certificate were used to identify maternal residence. The combined number of minority births from these cities in 1992 represented 18.1 percent of all minority births in the state.

The case groups (mothers with moderate or extreme preterm births) consisted of all liveborn singleton, preterm births, grouped according to moderately preterm (33 to 36 weeks gestation) and extremely preterm (18 to 32 weeks gestation). The control group (mothers with term infants, 37 to 44 weeks gestation) was selected from a 30 percent simple random sample of black births from each city. The study population consisted of 198 extremely preterm births, 246 moderately preterm births, and 652 term births.

Preterm births were categorized according to moderately preterm and very preterm in order to test the assumption that environmental risk would vary by gestational age. Those born moderately preterm, particularly 35-36 weeks gestation, are known to have long-term developmental outcomes similar to those of term infants, whereas infants born very preterm (less than 33 weeks gestation), who survive at birth, are more likely than all others to suffer from both short-term and long-term developmental problems[16].

Gestational age was determined from the last menstrual period (LMP) date, and when the LMP date was either missing or invalid, the clinical estimate was used. To reduce clinical or recording error associated with an improbable gestational age, all preterm births were restricted to those under 3,000 grams.

Address matching. GIS (Geographical Information System) computer technologies were used to match the mother's address available on the birth certificate. The 1993-94 database of county streets/roads, maintained by the North Carolina Public School System for school bus routes, was used to identify street names and numbers for each of the three cities. Matching birth certificate addresses to the city-street data base was accomplished with Arc Info software, so that each birth in the study population was assigned to a block group, for which aggregate characteristics were available.

The match rate obtained for the mother's address on the birth certificate was similar for cases and controls within each city, ranging from 94 to 98 percent. Non-matches were due primarily to PO boxes or rural routes listed on birth certificates, which meant that the city-county codes identifying a mother's residence within a North Carolina city were either in error or the mother may have used an address other than her city address. Comparatively few cases and controls (less than 3 percent) were eliminated because the birth certificate street name or street number could not be found or extrapolated from the database.

Definition of variables. *Environmental* variables were constructed from the 1990 Census TIGER (Topologically Integrated Geographic Encoding and Referencing System) files, which link geographic information (e.g., block groups) with population attributes (e.g., income). A block group was selected for analysis if one or more cases and/or controls were address-matched to the block group. Both income and neighborhood segregation were computed for households. The median household income for the block group was used to assess the mother's economic status. Block groups were stratified by five income categories: 1) less than $11,000, 2) $11,000 to $16,999, 3) $17,000 to $24,999, 4) $25,000 to $29,999, and 5) $30,000 and above. Residential segregation was computed from the proportion of black-owned or -rented households in each block group. Four categories of the percent of black households in each block group were constructed: 1) greater than or equal to 75 percent black households, 2) 50 to 74.9 percent, 3) 25 to 49.9 percent and 4) less than 25 percent.

Based upon previous research, the following *individual-level* risk factors were controlled for: smoking during pregnancy, prior fetal loss, and pre-existing medical conditions for the current pregnancy[2]. Medical risk was obtained from the medical history portion of the birth certificate. One or more medical conditions indicated for the current pregnancy was defined as a medical risk. Fetal loss was derived from the date (month, year) of the last fetal death on the birth certificate, and was defined as a risk if the death occurred within two years of the current pregnancy. Smoking during pregnancy was also obtained from the birth certificate.

Statistical methods. Data analyses were performed separately for moderate and extreme preterm births. Maternal demographics, use of public assistance (derived from linked data files at the State Center), and residential economic status were compared descriptively for cases and controls. The difference in the three pregnancy risk factors between cases and controls was examined using crude odds ratios.*

To estimate the independent or separate effect of neighborhood economic status and segregation status on the risk of preterm births, logistic regression was used. Logistic regression is a statistical modeling technique which may be used to estimate the simultaneous effect of a set of different factors (e.g., residence in high, medium, or low income block groups) on the outcome under investigation (e.g., extreme prematurity). An adjusted odds ratio is calculated for *each* factor, which is adjusted for the effect of all other factors included in the model. By using logistic regression, it is possible to estimate, for example, the independent risk of maternal residence in very low income areas on extreme preterm delivery, while controlling for smoking and other risk factors for preterm delivery.

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*Note: The crude odds ratios presented in this study express the amount by which mothers with preterm births (cases) and mothers with term births (controls) differ, for example, in their chances of smoking during pregnancy without consideration for any other factor (mother's education, for example) which might influence the relationship. An odds ratio of 1.0 implies the risks are identical for the two groups; odds ratios greater than 1 indicate an increased risk for the case group.

RESULTS

The demographic characteristics of the study population are shown in Table 1. The percent distribution of cases and controls by age was found to be somewhat similar. The proportion of teenage mothers (under 18 years old) was approximately the same for the controls (8.9 percent) and the extreme preterm cases (8.1 percent), while in the moderate preterm case group, teens represented close to 12 percent of the sample. For mothers aged 35 or older, the highest proportion was observed among the extreme preterm case group (8.6 percent); however, the actual number of mothers over age 34 was relatively small for all three groups.

With regard to education and marital status, both case groups (all mothers with preterm infants) were less likely to be married or have at least a high school education. These trends in demographic risk among cases also coincided with lower participation rates in the prenatal WIC Program (Supplemental Nutrition Program for Women, Infants & Children). Close to 60 percent of the control

Table 1
Demographic Characteristics of Controls, Moderate and
Extreme Preterm Cases; 1992 Black Births:
Raleigh, Greensboro, Charlotte, NC

Characteristic	Controls		Moderate Preterm		Extreme Preterm	
	No.	%	No.	%	No.	%
Maternal age:						
Under 18 yrs.	58	8.9	29	11.8	16	8.1
18-21 yrs.	181	27.8	70	28.5	50	25.3
22-34 yrs.	373	57.2	132	53.7	115	58.1
over 34 yrs.	40	6.1	15	6.1	17	8.6
Education:						
less than HS	154	23.6	78	31.7	65	32.8
HS or greater	498	76.4	168	68.3	133	67.2
Marital status:						
not married	410	62.9	180	73.2	144	72.7
married	242	37.1	66	26.8	54	27.3
Reimbursement:						
MCC*	105	16.1	47	19.1	37	18.7
WIC**	389	59.7	135	54.9	99	50.0
Total n	652		246		198	

*MCC – Maternity Care Coordination
**WIC – Supplemental Nutrition Program for Women, Infants and Children

Figure 1. Percent Distribution of Controls, Moderate & Extreme Cases by
Income Groups; 1992 Black Births: Raleigh, Greensboro,
Charlotte, NC
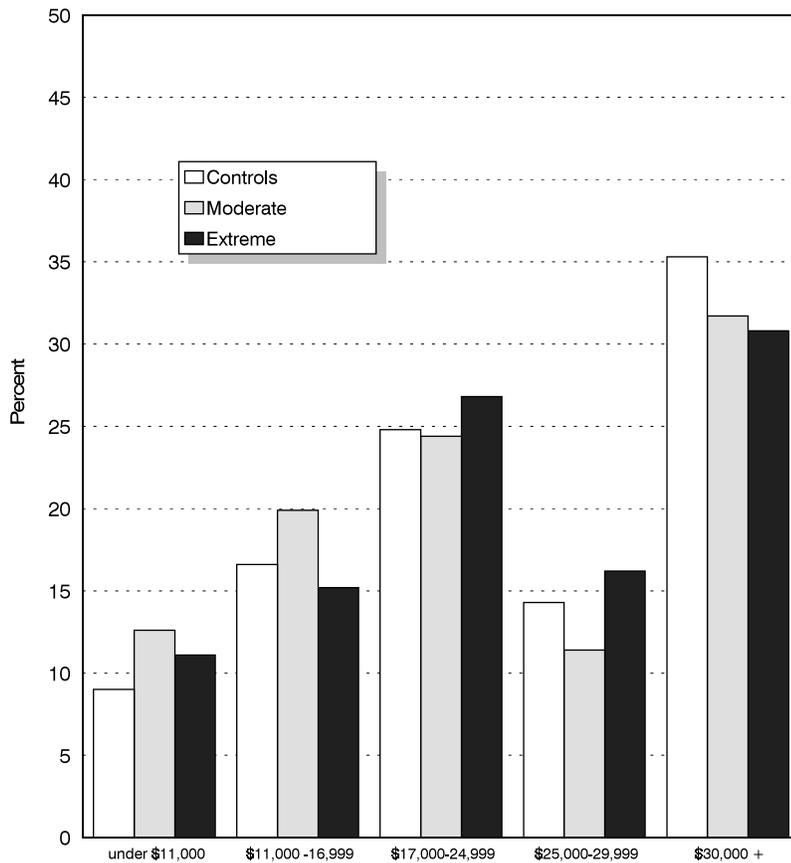
population was enrolled in WIC versus 54.9 and 50 percents for the moderate and extreme preterm cases respectively. The percentage of mothers receiving Maternity Care Coordination (MCC) services, on the other hand, was slightly higher among the preterm groups.

Figure 1 illustrates the percent distribution of cases and controls by block group income categories. Significant differences did not appear between the percent of cases and controls within any income category. Less than 15 percent of the study population resided in the poorest block groups

(income under $11,000), while more than 30 percent were observed in the highest income block groups (over $29,999). These data indicate that most black mothers in this study did not reside in predominantly poor neighborhoods.

Figure 2 shows the distribution of cases and controls by categories of residential segregation. These data reveal that the highest percentage of both cases and controls live in predominantly white neighborhoods (25% or less black households). Moderate preterm cases were significantly more likely than extreme preterm cases to live in block groups containing the lowest percentages of black households (Chi-square 6.5, p<0.05).

The crude odds ratios for the behavioral/medical risk factors, as previously defined, are shown in Table 2. Both moderate and extreme preterm cases were approximately twice as likely as controls to have reported smoking during pregnancy. The likelihood of a pre-existing medical condition was also higher for both case groups, particularly for the extreme preterm cases who were more than three times as likely as controls to have some type of medical risk. The risk of a prior fetal death, however, was not significantly different between controls and moderate preterm cases, but was significant for the extreme preterm case group. An estimate of the cumulative or total risk, derived from multiplying the odds ratios for all three risk factors, indicated that the extreme preterm group (OR=10.7) had an overall risk of approximately twice the magnitude of that for the moderate preterm group (OR=5.4).

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Figure 2. Percent Distribution of Controls, Moderate & Extreme Cases by Block Group Composition of Black Households; 1992 Black Births: Raleigh, Greensboro, Charlotte, NC
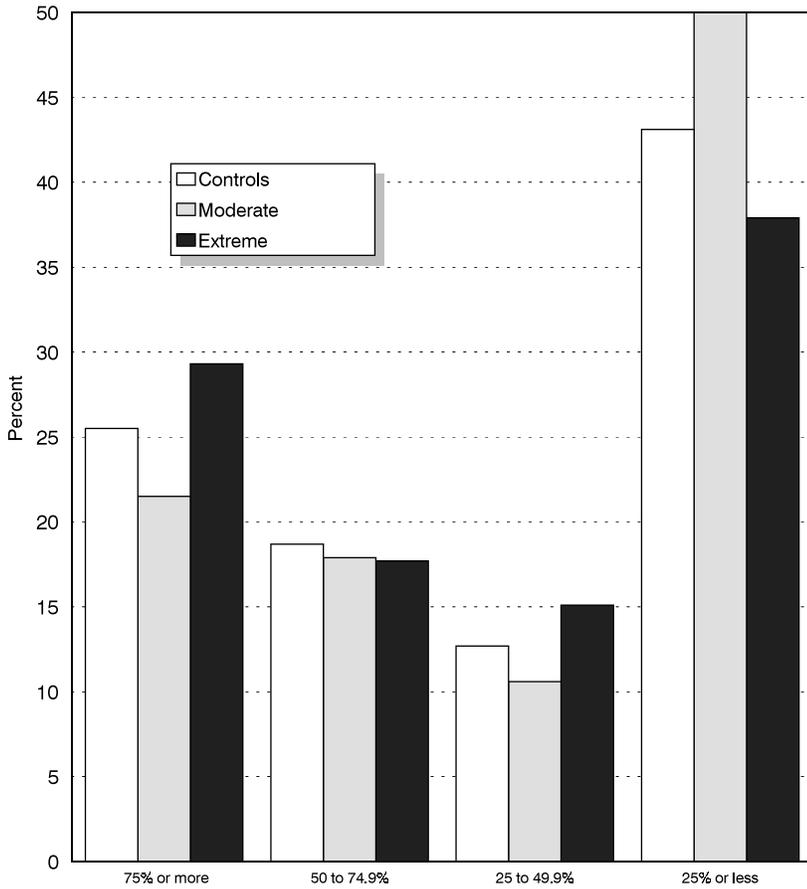
The adjusted odds ratios found in Table 3 estimate whether maternal residence in low-income or highly segregated block groups is independently associated with the risk of preterm delivery, after controlling for the effects of smoking, prior medical conditions, or prior fetal loss. More specifically, these odds ratios measure whether the risk of prematurity for moderate and extreme preterm cases changes with different levels of block group median household income or segregation status, in comparison to the controls.

The referent categories for the economic and segregation variables included maternal residence in block groups where the median household income exceeded $29,999, and where block group household occupancy rates were less than 25 percent black-owned or -rented. These categories were chosen to represent those neighborhoods where the risk for preterm births was assumed to be low.

Table 2
Crude Odds of Smoking during Pregnancy, Prior Medical Risk and Prior Fetal Loss among Moderate and Extreme Preterm Cases; 1992 Black Births: Raleigh, Greensboro, Charlotte, NC

	Moderate	Extreme
Pregnancy Risk Factor	OR (95% CI)	OR (95% CI)
smoking / pregnancy	1.8 (1.2–2.7)	2.1 (1.4–3.1)
prior medical risk	2.3 (1.6–3.1)	3.2 (2.3–4.5)
prior fetal loss	1.3 (0.9–2.1)	1.6 (1.0–2.6)

Controlling for behavioral and medical risk factors, there was no increased risk for moderate preterm births associated with residence in low-income or segregated block groups (Table 3). For all categories, the odds ratios were close to 1.0, indicating that the risk was approximately the same between the referent group and all other groups.

This was not the case, however, for mothers with very preterm births. There was, in fact, a measurable effect associated with neighborhood economic status. The risk of extreme prematurity for those mothers residing in the lowest-income block group was found to be two times that of mothers resid-

ing in the highest-income block groups ($30,000 or more).

Mothers living in highly segregated block groups (more than 75 percent black households) had a reduced risk of extreme prematurity compared to those living in non-segregated block groups, after controlling for neighborhood economic status and other risk factors. The risk of extreme prematurity was about 40 percent less for black women living in predominantly black neighborhoods compared to black women living in predominantly white neighborhoods (under 25 percent black households; Table 3).

Table 3
**Adjusted Odds of Preterm Risk among Moderate and
Extreme Cases, Associated with Block Group Characteristics
(Logistic Regression): Case Control Study of 1992 Preterm Births
among Blacks in Urban NC**

Block Group	Moderate OR (95% CI)		Extreme OR (95% CI)	
[1]Median Household Income				
less than $11,000	1.3	(0.7–2.4)	2.1	(1.1–4.2)
$11,000 – 16,999	1.1	(0.7–1.9)	1.3	(0.7–2.5)
$17,000 – 24,999	0.9	(0.6–1.5)	1.4	(0.8–2.2)
$25,000 – 29,999	0.8	(0.5–1.4)	1.4	(0.8–2.3)
$30,000 (referent group)	1		1	
[2]Percent Black Households				
75% or more	1.2	(0.7–1.9)	0.6	(0.3–0.9)
50 – 74.9%	1.0	(0.6–1.8)	0.9	(0.5–1.6)
25 – 49.9%	1.2	(0.7–1.9)	0.7	(0.4–1.2)
under 25% (referent group)	1		1	

[1]Model parameter estimates adjusted for (1) smoking during pregnancy, (2) medical risk for current pregnancy, (3) prior fetal loss, and (4) percent black households.

[2]Model parameter estimates adjusted for (1) smoking during pregnancy, (2) medical risk for current pregnancy, (3) prior fetal loss, and (4) median household income.

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COMMENT

Limitations. The results of this study should be interpreted in consideration of several limitations.

The use of birth certificate data entails the risk of inaccurate or incomplete reporting. The reliability of LMP dates or clinical estimates of gestational age, as reported on the birth certificate, have been questioned. In an evaluation study of California medical records and birth certificate data, only 80 percent of the LMP dates on the birth certificate agreed with medical records, although most disagreements were less than a week apart[18]. In the present study, this type of error may lead to some infants being misclassified in one or more of the study groups. Assuming such misclassification is random, the results of this study would be biased in the direction of the null hypothesis (i.e., the observed associations might appear weaker than they actually are).

Error is also likely to occur in the reporting of the mother's medical history. Based on a study of a random sample of North Carolina birth certificates, it was shown that the mother's medical history on the birth certificate agreed with hospital medical records only 58.5 percent of the time. Three of the conditions most often missed are known risk factors for preterm births: anemia, diabetes, and hypertension[19].

An additional source of error may occur with the use of block group median household income as a measure of individual economic status. Median household income does not take into account the number and age of persons supported. For example, a household income of $18,000 would have very different implications for a family of one adult versus a family of two adults and two children. Therefore the use of block group median household income is, at best, a rough approximation of living standards in an individual household.

Analysis of results. This study indicates that environmental factors have an effect only upon the risk of extreme prematurity among black mothers residing in three North Carolina cities. Maternal residence in the poorest neighborhoods poses an independent risk (in addition to individual risk factors) for black babies born extremely preterm, but not for black babies born moderately preterm.

This link between residential poverty and extreme prematurity among blacks has not been reported elsewhere. However, it is known that prematurity is one of the primary causes of neonatal mortality and that black neonatal mortality appears elevated among low-income groups[20]. Furthermore, maternal residence in poor neighborhoods has been associated with late or no prenatal care, which, in turn, is a strong predictor of premature delivery[21-22]. These results, therefore, regarding the association between poverty and the risk of extreme preterm births among blacks, are consistent with other studies.

Contrary to what was expected, maternal residence in predominantly black neighborhoods significantly lowered the risk of extreme prematurity, while neighborhood segregation status had no effect on the risk of moderately preterm births.

The association observed between residential segregation and extreme prematurity is not consistent with the results of previous research. As cited earlier, Polenak found that segregation, measured at the census tract-level, was an independent predictor of the difference in the black/white rate of infant mortality. Though the outcome of this study cannot be directly compared with Polenak's study, we might have expected similar results; residence in mostly black neighborhoods could be assumed to be associated with higher pregnancy risk. Our results, however, did not support this assumption.

The mechanisms by which residence in predominantly black neighborhoods could reduce the risk of extreme prematurity for this study population

are not known. In the urban areas examined, there was little evidence of a relationship between neighborhood segregation and poverty. In additional analyses, it was found that block group income status explained only a moderate amount of the variation in block group segregation status (results not shown). Also, no joint effect was observed; that is, maternal residence in *both* highly segregated and low-income block groups was not an independent risk factor for either the extreme or moderately preterm cases. These results suggest that the distribution of black households in North Carolina urban areas may not follow socioeconomic divisions that are more typical of other urban areas in the country, particularly that of the older, northern industrialized cities, which contain closely-packed, inner-city zones of poverty and social disorganization.

Conclusion. This study's results indicated that environmental effects were evident only among the extreme preterm group for black mothers in three North Carolina cities. Maternal residence in the lowest-income block groups was independently associated with a two-fold increased risk in extreme preterm delivery. Conversely, maternal residence in predominantly black neighborhoods was independently associated with a reduced risk for extreme preterm delivery.

Additional research, however, will be needed to confirm the relationships observed here between extreme prematurity, household economic status, and neighborhood segregation. Because of the limitations previously noted, it is important to re-emphasize that the results of this exploratory study must be considered with caution.

Implications for Public Health Practice. The study of neighborhoods – as defined by block groups – may generate a broader understanding of the relationship between the environment and the individual. It may also promote identification of specific environmental factors likely to elevate or diminish a woman's risk for preterm birth.

Assuming additional evidence of the link between poverty and extreme prematurity among black women, it is reasonable to propose that residence in very low income urban areas be considered an independent risk for extreme preterm delivery. The mechanisms by which poverty adversely affects pregnancy are fairly well understood. Inadequate prenatal nutrition, high risk maternal behaviors, such as smoking, and poor access to health care have all been documented among women who live in impoverished neighborhoods[20]. The practice of prenatal screening for preterm delivery might subsequently benefit from including an assessment of the mother's standard of living and perception of her environment or neighborhood.

If further study also demonstrates that residence in predominantly black neighborhoods tends to reduce risk of extreme prematurity, it would be reasonable to propose a mechanism for this relationship. It could be that residence in predominantly black neighborhoods provides a higher degree of social connectedness or social support among pregnant black women, than that found in mixed or predominantly white neighborhoods. Much public health research and practice has recognized the value of social support in promoting positive birth outcomes[23]. Assuming a link between neighborhood composition and social support, it may also be useful to explore this relationship in practice by including a prenatal assessment of the mother's neighborhood support network, when evaluating her risk for prematurity.

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